20.0 UPPER WILLAMETTE SPRING CHINOOK SALMON ESU

20.1 BACKGROUND

20.1.1 Description of the ESU

Upper Willamette River spring chinook are one of the most genetically distinct groups of chinook in the Columbia River Basin (Myers *et al.* 2002). Historically, passage by returning adult salmonids over Willamette Falls (RKm 37) was only possible during the winter and spring high flow periods. The early run timing of Willamette River spring chinook salmon relative to other Lower Columbia River spring run populations is viewed as an adaptation to flow conditions at the Falls. Chinook salmon begin appearing in the lower Willamette River in February, but the majority of the run ascends the Falls in April and May, with a peak in mid-May. Low flows during the summer and autumn months prevented fall run salmon from accessing the Upper Willamette River Basin. Mattson (1963) discusses the existence of a late spring run chinook salmon that ascended the falls in June. These fish were apparently much larger (25-30 lbs. (11.4-13.6 kg)) and older (presumably 6-year-olds) than the earlier part of the run. Furthermore, Mattson (1963) speculated that this portion of the run “intermingled” with the earlier-run fish on the spawning ground and did not represent a distinct run. The disappearance of the June run in the Willamette River in the 1920s and 1930s was associated with dramatic decline in water quality in the lower Willamette River.

Spring chinook populations in this ESU exhibit a life history pattern that includes traits from both ocean- and stream-type life histories. Smolt emigrations occur as young of the year and as age-1 fish in the fall and spring (Schroeder *et al.* 2004). Ocean distribution of chinook in this ESU is consistent with an ocean-type life history with the majority of chinook being caught off the coasts of British Columbia and Alaska. Spring chinook from the Willamette River have the earliest return timing of chinook stocks in the Columbia Basin with freshwater entry beginning in February. Adults return to the Willamette River primarily at ages 3 through 5 (King 2004). Historically, spawning occurred between mid-July and late October. However, the current spawn timing of hatchery and natural-origin chinook is September and early October (Schroeder *et al.* 2004).

Historically, there were five major river basins that produced spring Chinook, including the Clackamas, North Santiam, South Santiam, McKenzie, and the Middle Fork Willamette. Smaller populations also existed historically in the Molalla River and Calapooia River. The Willamette/Lower Columbia Technical Recovery Team (Myers *et al.* 2002) identified all seven of these rivers as having independent spring chinook populations historically (Table 20.1).

Table 20.1. List of natural populations identified by the Lower Columbia/Willamette TRT (Myers *et al.*, 2002), hatchery programs in each population area, and description of the current hatchery program.

TRT Spring chinook populations	Hatchery Program (included, not included ESU)	Integrated or Isolated Program	Program description	Size of program (smolts)	Year in operation
Clackamas	Clackamas (included ESU)	integrated	smolt	1.3 million	1979
Molalla	S. Santiam (included ESU)	integrated	smolt	100,000	1990
North Santiam	N. Santiam (included ESU)	integrated	smolt	667,000	1950
South Santiam	S. Santiam (included ESU)	integrated	smolt	1.1 million	1968
Calapooia	S. Santiam (included ESU)	integrated	adult	no smolts, live adults	1990
McKenzie	McKenzie (included ESU)	integrated	smolt	985,000	1930
Middle Fork	Middle Fork (included ESU)	integrated	smolt	1.4 million	1957
Summary: Seven TRT natural populations; all with hatchery programs. Five hatchery stocks all included as part of the ESU. 5.5. million annual smolt production goal.					

Clackamas- The Clackamas River population consists of naturally-produced spring chinook and the Clackamas hatchery stock (ODFW stock #19). Most of the natural production of spring chinook occurs above North Fork Dam on the Clackamas River. Since 1990 the broodstock collected for this hatchery program has been from fish returning to the Clackamas hatchery trap. The hatchery stock likely resembles native Clackamas fish more than any other stock of fish in the Willamette Basin. Substantial numbers of natural-origin fish have not been incorporated into the broodstock. However, since 2000, the hatchery stock has been managed as an integrated stock (NMFS 2000). This hatchery stock was designated as part of the ESU.

Molalla- The native population of spring chinook in the Molalla River is believed to be extinct or nearly so (Myers *et al.* 2002). In recent years, smolts from the South Santiam Hatchery have been outplanted into the Molalla River. The South Santiam Hatchery stock (ODFW stock #24) was determined to be part of the ESU.

North Santiam- The North Santiam River population consists of naturally-produced spring chinook and the Marion Forks Hatchery stock (ODFW stock #21). This hatchery stock was developed from spring chinook returning to the North Santiam River and was determined to be part of the ESU.

South Santiam- The South Santiam River population consists of naturally-produced spring chinook and the South Santiam Hatchery stock (ODFW stock #24). This hatchery stock was developed from spring chinook returning primarily to the South Santiam River and was determined to be part of the ESU.

Calapooia- The native population of spring chinook in the Calapooia River is believed to be extinct or nearly so (Myers *et al.* 2002). In recent years, live adults from the South Santiam Hatchery have been outplanted into the Calapooia River. The South Santiam Hatchery stock (ODFW stock #24) was determined to be part of the ESU.

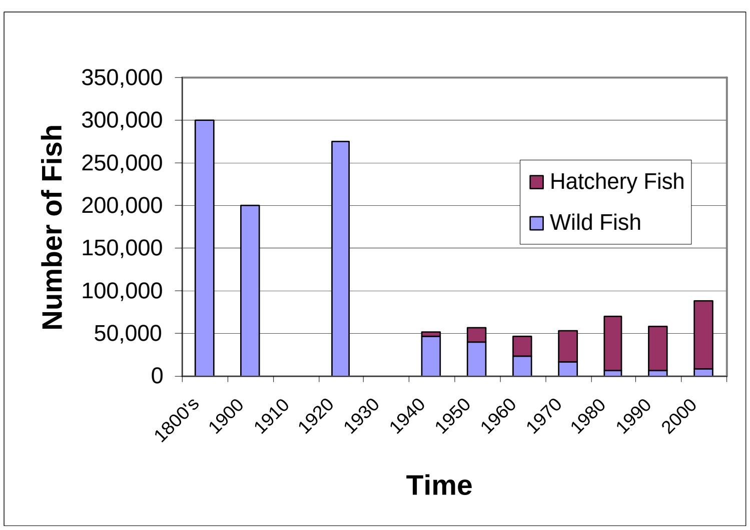
McKenzie- The McKenzie River population consists of naturally-produced spring chinook and the McKenzie hatchery stock (ODFW stock #23). This hatchery stock was developed from spring chinook returning primarily to the McKenzie River and was determined to be part of the ESU.

Middle Fork Willamette- The Middle Fork Willamette population consists of naturally-produced spring chinook and the Willamette hatchery stock (ODFW stock #22). This hatchery stock was developed from spring chinook returning to the Middle Fork Willamette River and was determined to be part of the ESU. A small run of native spring chinook also existed historically in Fall Creek, a tributary to the Middle Fork, and is also included in this population.

20.1.2 Status of the ESU

All of the rivers below were identified as historically harboring spring chinook populations by the TRT. The BRT report (2003) did not address individual VSP parameters for this ESU.

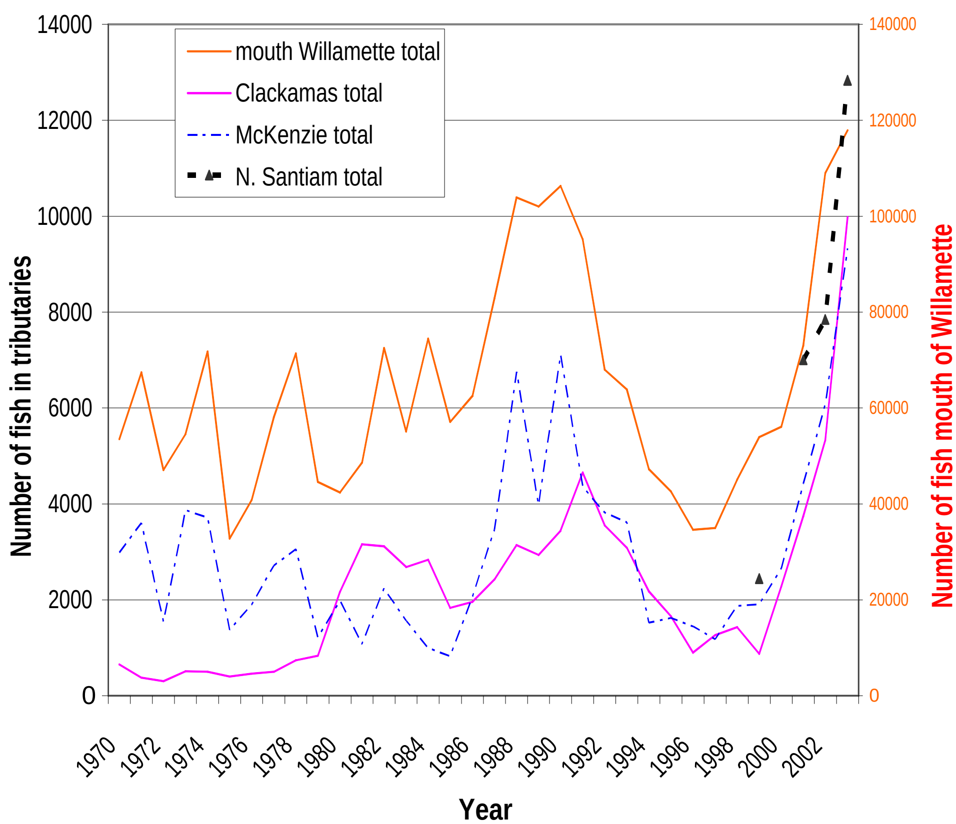
Figure 20.1. Estimated total abundance of spring chinook returning to the mouth of the Willamette River (Myers *et al.* 2002; King 2003; King 2004).



Clackamas- The Clackamas River still supports a relatively healthy run of natural-origin and hatchery-origin fish. Counts of natural-origin fish at North Fork Dam, located on the mainstem Clackamas River below the major natural production areas, numbered more than 2,200 fish in 2002 and 3,600 fish in 2003 (King 2004). The number of hatchery fish observed at the dam (which were not allowed to pass upstream) was 3,000 to 6,000 fish in 2002 and 2003.

Molalla- A small population of spring chinook existed historically in the Molalla. In recent years, few naturally-produced fish have been observed. In 2002 and 2003, less than 7% of the natural spawners were of natural-origin (Schroeder *et al.* 2003, 2004). The hatchery spring chinook released into the Molalla are from South Santiam stock. This non-local hatchery stock makes up most of the spawners present in this river. The BRT (2003) found that this population was likely extirpated, or nearly so.

Figure 20.2. Total number of hatchery AND wild spring chinook returning to the Willamette River (right Y axis) and tributaries with counting facilities (left Y axis). Counts measured at North Fork Dam on the Clackamas, Leaburg Dam on the McKenzie, and Bennett Dams on the North Santiam. Data from King (2004).



North Santiam- The total return of spring chinook to the North Santiam River has numbered in the thousands of fish annually. However, from 2000 to 2003 (the first years when hatchery fish could be differentiated from wild fish), the average number of natural-origin fish was only 384 fish. In 2003, an estimated 681 natural-origin fish passed Bennett Dams on the lower North

Santiam River compared to more than 11,000 hatchery fish (Firman *et al.* 2004). The BRT (2003) did not consider this population to be self-sustaining.

South Santiam- The estimated abundance of natural-origin fish returning to the South Santiam River in 2002 and 2003 (the only years when 100% of the hatchery fish returns could be differentiated from naturally-produced fish) was 965 and 635 adults, respectively (Firman *et al.* 2003, 2004). Even though these numbers are low, it is encouraging to see some natural production for this population. Since most of the naturally spawning fish are of hatchery-origin, it is likely that most of the naturally-produced fish are from hatchery parents. Most of these natural-origin fish were released into historic habitat above Foster Dam (impassable dam). The return of hatchery fish to the South Santiam has numbered several thousand fish annually. High densities of redds have been observed below Foster Dam in recent years. In 2003, more than 600 redds were counted below the dam. Most of the spawners are hatchery fish (Schroeder *et al.* 2004). The BRT (2003) concluded this population is not self-sustaining.

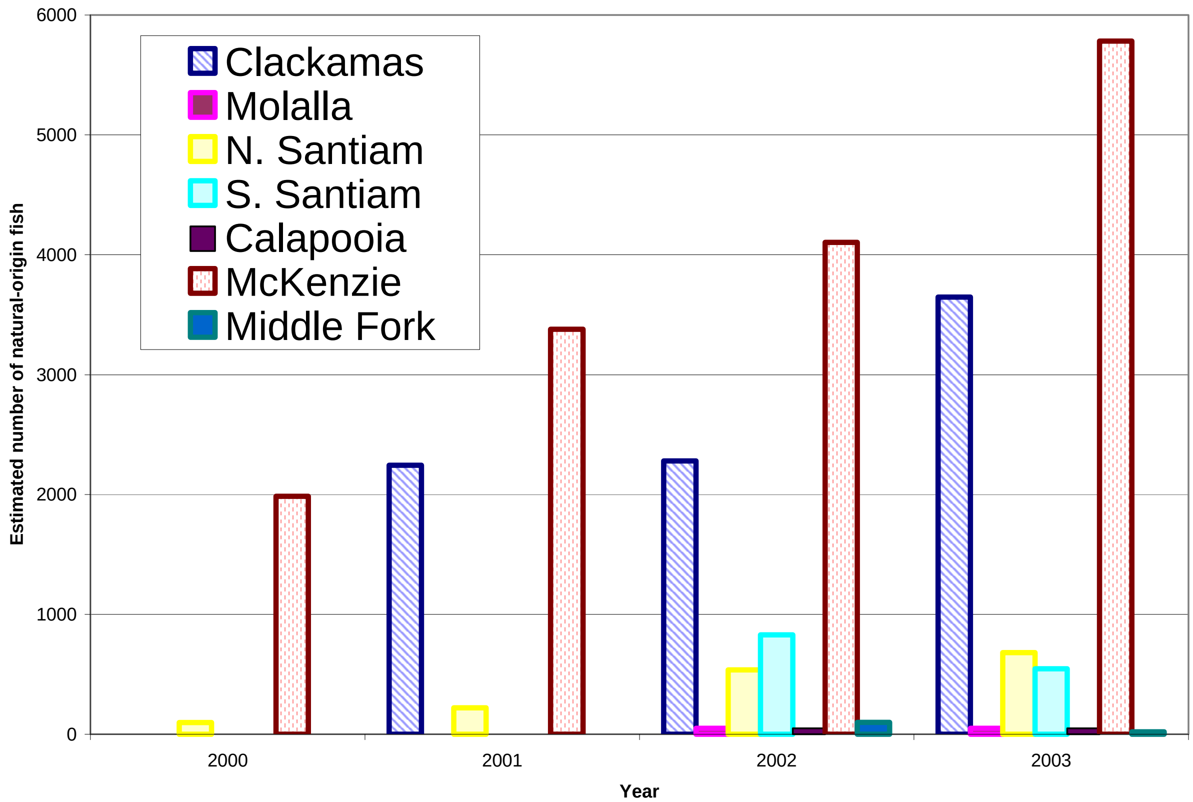
Calapooia- The Calapooia River historically supported a population of spring chinook that numbered in the range of a few hundred fish. It is believed the historic population is extinct, with limited future production potential (Myers *et al.* 2002). Recent spawning ground surveys have shown few redds, even though hatchery adult spring chinook are outplanted into the Calapooia River from South Santiam Hatchery. In 2003, even though 140 hatchery chinook were outplanted into the Calapooia River (Firman *et al.* 2004), Schroeder *et al.* (2004) observed only two redds in 7.9 miles of survey. Over 90% of the carcasses recovered were hatchery fish. The Calapooia natural spring chinook population is believed to be extirpated, or nearly so (BRT 2003).

McKenzie- The McKenzie River is only one of two rivers in the ESU where most of the historic habitat is still accessible (Clackamas River is the other river). The run of naturally-produced spring chinook in the McKenzie River is the stronghold for the ESU. Since 1994, the number of naturally-produced adults has ranged from less than 1,000 fish to more than 5,500 fish in 2003 (Figure 20.3). The returns of natural fish to the McKenzie is greater than any other river in the ESU. Returns of hatchery spring chinook to the McKenzie have also numbered in the thousands of fish annually since the early 1970s (Figure 20.8). The BRT (2003) stated it was difficult to determine if this population would be naturally self-sustaining because of the presence of naturally-spawning hatchery fish above Leaburg Dam (the area where most of the natural production occurs).

Middle Fork Willamette- Over 80% of the historic habitat for spring chinook was blocked by the construction of Dexter, Lookout Point, and Hills Creek dams in the Middle Fork basin. Since 2001, hatchery spring chinook can be distinguished from naturally-produced fish because they have an adipose fin clip. In 2002 and 2003, an estimated 987 and 147 adults, respectively, were naturally-produced spring chinook (Firman *et al.* 2004). Most of these fish were likely produced from outplants of adult hatchery fish above the dams because juvenile and adult survival below Dexter Dam is poor (Schroeder *et al.* 2002, 2003; ODFW Middle Fork HGMP 2004). The returns of hatchery spring chinook to the Middle Fork have numbered in the thousands of fish annually since the early 1970s. In 2002 and 2003, more than 6,000 hatchery spring chinook were collected at Dexter Dam. Returns of hatchery fish of this magnitude were common since 1970. The BRT (2003) did not consider this population to be self-sustaining.

The BRT (2003) considered hatchery production to be a potential risk factor to natural fish in this ESU. The BRT was concerned that hatchery fish were masking the productivity of the natural populations, interbreeding with natural fish thereby posing genetic risks, and that hatchery-origin adult returns promote fisheries that increase mortality on natural fish. The BRT concluded that most natural populations are likely extirpated, or nearly so. The only population considered potentially self-sustaining is the McKenzie. However, hatchery fish comprise a substantial proportion of the run.

Figure20.3. Estimated returns of natural origin fish to each population area. Actual number of spawners is lower in the N. Santiam, S. Santiam, McKenzie, and Middle Fork due to prespawning mortality. For these rivers, estimates are from dam counts. In the Molalla and Calapooia rivers, estimates are number of spawners.



20.2 ASSESSMENT OF HATCHERY PROGRAMS

All of the hatchery programs are currently using broodstocks that are integrated with the local, natural stocks. The extent to which natural-origin fish have been incorporated into the broodstocks is unknown because hatchery and natural fish could not be differentiated until recently when all hatchery fish returns were marked. The Calapooia and Molalla Rivers are the only rivers where out-of-basin fish are stocked. South Santiam Hatchery liberates juvenile and adult fish into these two rivers.

There are no natural populations in the ESU that are *not* affected to some degree by hatchery programs. Even the McKenzie River, the stronghold population for the ESU, has had substantial numbers of hatchery fish spawning naturally in recent years.

20.2.1 Clackamas

The Clackamas River currently supports a natural run of spring chinook that has averaged about 1,600 adults from 1996-2003 (Schroeder *et al.* 2004). It is important to note that this count represents a high estimate and the true number of natural fish is likely lower because some hatchery fish did not have an external fin clip during this time period. Nearly all of the natural production within this subbasin occurs upstream of North Fork Dam (Schroeder *et al.* 2002, 2003, 2004). The Clackamas River is one of two areas within the ESU with the highest return of natural-origin fish in recent years (the McKenzie is the other river).

20.2.1.1 Broodstock History. The current Clackamas hatchery program was developed from other Willamette basin hatchery fish stocked as smolts into the Clackamas River beginning in 1976. Prior to the current program being initiated, hatchery fish were from both local returns and imports from other Willamette broodstocks (Myers *et al.* 2002). Since 1990 the broodstock for this program has been collected from fish returning to the Clackamas River.

20.2.1.2 Similarity between hatchery origin and natural origin fish. The native spring chinook run in the Clackamas River declined substantially over the last century due to Cazadero and River Mill dams that limited migratory access to the majority of the historical spawning habitat in the basin. The run upstream of the dams was at very low levels from the 1940's until the first returns of the current program in 1980. Returns have steadily increased over the last two decades. Myers *et al.* (2002) stated the current hatchery program has significantly introgressed into, if not overwhelmed, the native population in the Clackamas River. Given hatchery and natural fish could not be differentiated from each other until recent 100% marking of hatchery releases, many hatchery fish have likely spawned naturally. The hatchery and natural-origin components of this population are likely more genetically similar to each other than other hatchery or natural fish in the ESU (Myers *et al.* 2002).

20.2.1.3 Program Design. The Clackamas spring chinook hatchery program is funded by Portland General Electric, City of Portland, and the Mitchell Act to mitigate for fishery losses caused by dams in the basin. The program is intended to provide fish for commercial and recreational harvest. Hatchery spring chinook are not purposefully allowed to spawn naturally. Hatchery spring chinook that migrate upstream to North Fork Dam are removed to the extent possible and recycled downstream through the fishery or taken to the hatchery. The management goal is to limit hatchery fish to 30% or less of the spawning population above North Fork Dam (NMFS 2000). However, in recent years nearly all of the adipose fin-clipped fish have been removed.

20.2.1.4 Program Performance. The *smolt-to-adult* survival rate of the Clackamas Hatchery stock has averaged 0.53% for brood years 1987-1996 (Figure 20.5; ODFW South Santiam HGMP 2004). The broodstock goal for the current production level is approximately 1,500 fish. Total returns of hatchery fish from this program has exceeded the broodstock goal since the late 1980s (Figure 20.4). Prior to 1990, broodstock from other rivers were used to backfill production needs due to insufficient returns back to Clackamas Hatchery. NMFS (2000) directed the comanagers to use only broodstock returning back to the Clackamas River and not use broodstock from any other sources. Funding for this program comes from mitigation agreements with Portland General Electric, City of Portland, and the Mitchell Act. The long-term funding outlook for this program is fairly certain, although Mitchell Act funding has been uncertain in recent years.

20.2.1.5 VSP Effects

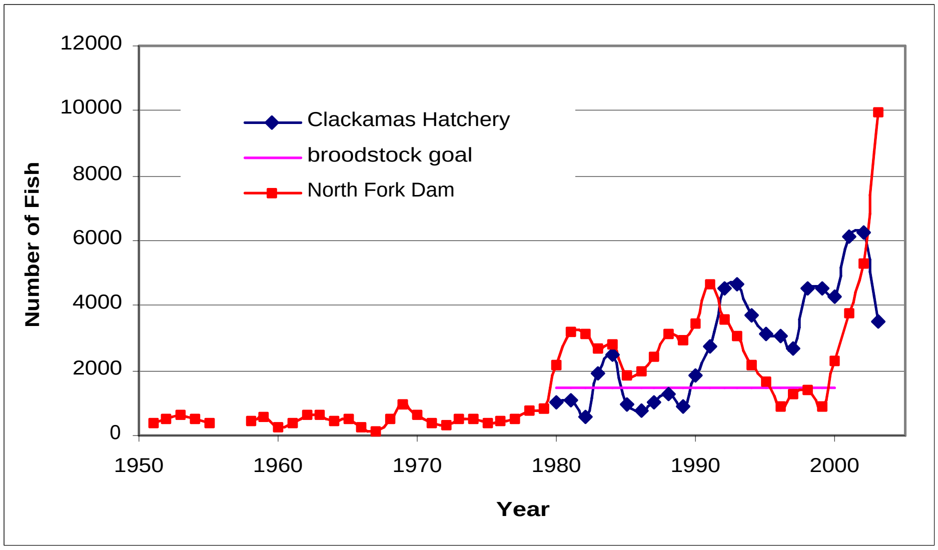
Abundance - The hatchery program is increasing the number of natural spawners above and below North Fork Dam. In 2002, an estimated 31% of the fish recovered above North Fork Dam during spawning surveys were hatchery fish (Schroeder *et al.* 2004). Below North Fork Dam, the number of spawners has been less than 200 fish since 1992 and most of the fish are of hatchery origin (King 2004). It is unknown how many offspring the hatchery fish spawners are producing since hatchery and natural fish are intermixed on the spawning grounds. It is important to note, however, the number of spring chinook passing North Fork Dam averaged around 500 fish from 1960 to 1980. Counts increased to more than 2,000 fish in 1981, the first year of Clackamas Hatchery returns. Counts in subsequent years have numbered in the thousands with the return in 2003 being the highest on record (King 2004). From 2001 to 2003, the number of non-adipose finclipped fish passing North Fork Dam has been in the range of 2,000 to 3,500 fish.

Returns of spring chinook back to the hatchery facility have averaged 2,800 fish from 1980 to 2003 (Figure 20.4). Over the last 23 years, there have only been eight years when returns back to the hatchery were below the broodstock goal. However, many of the hatchery fish bypass the collection facility and continue migrating upstream. Collections of hatchery fish at North Fork Dam, upstream of the hatchery, have indicated in some years more hatchery fish are observed at the dam than are collected at the hatchery. In 2003, 3,500 fish were collected at the hatchery and 6,300 marked hatchery fish were collected upstream at North Fork Dam (King 2004). This program has demonstrated a steady return of hatchery fish in excess of broodstock needs. There appears to be little risk of not meeting the broodstock goal on an annual basis when hatchery fish can be collected at the hatchery and North Fork Dam.

Productivity - It is not known whether the hatchery program is increasing or decreasing the productivity (measured as the number of recruits produced per spawning fish) of the naturally spawning population. If hatchery fish were just as successful as natural fish, then the productivity rate of hatchery fish would be the same as natural fish. If hatchery fish spawning naturally resulted in fewer recruits the next generation compared to having no hatchery fish spawning naturally (all else being equal), then productivity of the natural population would be reduced by the hatchery program. It is difficult, if not impossible, to quantify the effects of naturally spawning hatchery fish on the natural population when many other environmental and habitat factors also contribute to the productivity of any brood year.

Since some hatchery fish are spawning naturally, there would be some benefits of the program by providing additional carcass nutrients to the ecosystem after the fish spawn and die. This could help increase juvenile fish production.

Figure 20.4. Returns of spring chinook to Clackamas hatchery and North Fork Dam. The first adult returns to Clackamas hatchery began in 1980.



Spatial Structure - The Clackamas Hatchery program is not affecting the spatial structure of this population. Spring chinook can still access historic headwater habitat since fish ladders exist on River Mill and North Fork dams. Hatchery fish are not being reintroduced into unoccupied habitat. No hatchery weirs or hatchery facilities are impeding migration for spring chinook.

Diversity - The life history characteristics of hatchery spring chinook currently in the Willamette Basin differ from those of the historic run. The hatchery fish life history is simplified compared to natural fish. Most of the hatchery fish are released as age-1 smolts in the spring. Whereas in the historic populations, a more continuous emigration of smolts was observed through the fall and spring periods. Hatchery chinook return at an earlier age than the historic populations. Most of the returns now are age-4 fish instead of age-5 (Willis *et al.* 1995). Given these differences, there are potential risks from having hatchery fish interbreeding with the naturally spawning population. Over the last 20 years hatchery fish have undoubtedly interacted with the natural population on the spawning grounds. However, future management of the program is to reduce the number of hatchery fish spawning upstream of North Fork Dam so that a naturally produced run of spring chinook can be maintained. Natural-origin returns have been above critical run levels necessary to avoid demographic and genetic risks from low spawner numbers. Reestablishment of some natural life history diversity in the wild without the continual input of hatchery spawners should help long term viability of this population. Controlling the number of hatchery fish spawning in the wild will also allow the sustainability of the wild run to be evaluated over time without the masking effects of hatchery fish.

20.2.2 Molalla

The Molalla River historically supported a demographically independent population of spring chinook that is now extirpated, or nearly so (Myers *et al.* 2002). In recent years, nearly all of the natural spawners observed in the Molalla have been of hatchery-origin (Schroeder *et al.* 2004).

Smolts from South Santiam hatchery have been stocked into the Molalla and represent most of the hatchery fish on the spawning grounds. Few redds have been observed from natural or hatchery fish. In 2003, a year of large returns of chinook throughout the Willamette Basin, Schroeder *et al.* (2004) observed 15 redds in over 11 miles of surveyed stream.

It is apparent the Molalla River does not support a viable population. The natural population is functionally extinct and the outlook for recolonization of the Molalla by natural-origin fish from other nearby areas is unlikely. The most promising hope for rebuilding a natural run of spring chinook is by using hatchery fish. The current stock of fish in the Molalla is from the South Santiam Hatchery. This stock of fish is not the ideal stock of fish to use for reintroduction efforts, but a local stock does not exist. It is unclear at this time whether the South Santiam stock would be the best hatchery stock. It seems a hatchery program could benefit the reestablishment of a natural population in the Molalla River once the most appropriate stock of fish and type of release (adult, fry, smolt) is determined. Habitat degradation is the primary factor limiting future production and recovery of a spring chinook population in the Molalla River. The high prespawning mortality rates of adult spring chinook in recent years (Figure 20.11) make the prospects of using hatchery fish to reestablish a self-sustaining run very poor.

20.2.3 North Santiam

The North Santiam River historically supported a population of spring chinook that numbered in the thousands (NMFS 2000). The current run of natural fish has averaged less than 400 adults crossing Bennett Dams on the lower North Santiam River from 2000 to 2003 (Schroeder *et al.* 2004). The actual number of natural fish surviving to spawn is even lower since pre-spawning mortality of adults has ranged from 52% to 75% from 2001 to 2003 in the North Santiam below Big Cliff Dam (Figure 20.11; Schroeder *et al.* 2004). This natural population is not sustaining itself at a viable level.

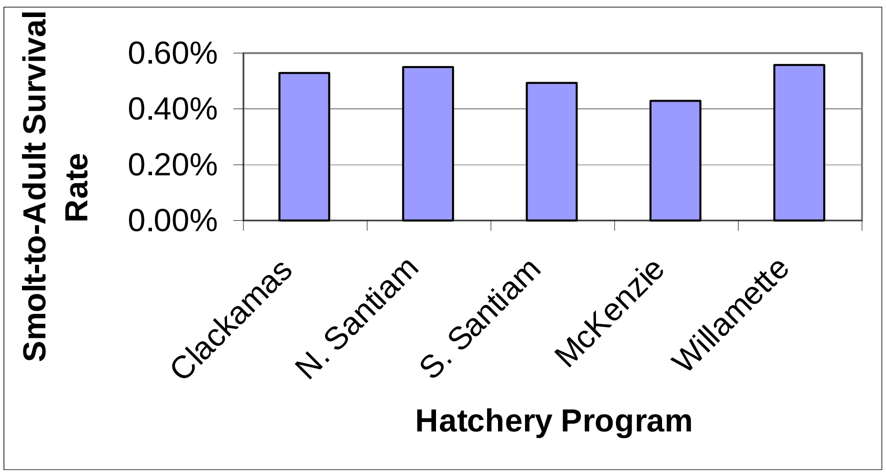
20.2.3.1 Broodstock History. The current hatchery program began in 1950 after completion of Detroit and Big Cliff dams that blocked upstream access to approximately 70% of the spawning area for spring chinook. Broodstock have been collected from returns to the base of Big Cliff Dam or Minto collection facility (downstream a few miles from the dam). Prior to the current program, hatchery fish were released from both local and non-local sources since the first egg take in 1911 (Myers *et al.* 2002). The current program uses an integrated stock, and has not imported out of basin stocks.

20.2.3.2 Similarity between hatchery origin and natural origin fish. Recent genetic analyses of hatchery and natural chinook in the North Santiam showed these stocks to be most closely related to other natural and hatchery runs in the Upper Willamette ESU (Myers *et al.* 2002). The hatchery component of the run was more closely related to natural fish in the McKenzie River than local, natural fish in the North Santiam. However, samples for each group were from different years. Myers *et al.* (2002) did not show a geographic pattern throughout the ESU, which was not expected, and stated relatively low sample sizes from juvenile fish may have produced misleading results for natural-origin fish.

20.2.3.4 Program Design. The program is to mitigate for federal dams in the basin and provide fish for harvest. All smolt releases are adipose fin-clipped. In recent years, the program has also been outplanting hatchery fish upstream of the impassable dams in the North Santiam to reintroduce fish back into historic habitat. All of the fish spawning above Detroit Dam have been hatchery fish. Below the dams, hatchery fish comprise more than 50% of the spawners. In the Little North Santiam River, natural fish collected from Minto trap have been outplanted to supplement natural spawning. The few fish surviving to spawn have been predominately natural fish.

20.2.3.5 Program Performance. The *smolt-to-adult* survival rate of the N. Santiam Hatchery stock has averaged 0.55% for brood years 1987-1996 (Figure 20.5; ODFW North Santiam HGMP 2004). The broodstock goal for the current production level is approximately 600 fish. Total returns of hatchery fish from this program has exceeded the broodstock goal since 1970 in all years except for 1979-80 (Figure 20.6). Only fish from local returns are used for broodstock (NMFS 2000). Funding for this program comes from Corps of Engineers and ODFW. The long-term funding outlook for this program is very certain.

Figure 20.5. Average *smolt-to-adult* survival rates of spring chinook returning to hatchery facilities. Data are for brood years 1987-96 (ODFW South Santiam HGMP 2004).



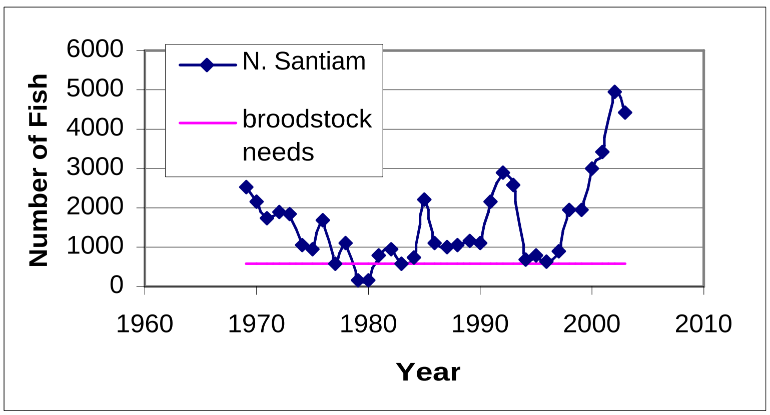
20.2.3.6 VSP Effects

<u>Abundance</u>- Returns of hatchery fish to the North Santiam have numbered in the thousands annually. In 2003, the estimated run of hatchery spring chinook crossing the Bennett Dams exceeded over 12,000 fish (King 2004). Most of these hatchery fish are collected upstream at Minto Dam (the end of the line for natural upstream migration) and taken for broodstock or outplanted above Detroit Dam into historic habitat to spawn naturally. The unmarked chinook collected at Minto Dam have either been incorporated into the hatchery broodstock (very few) or outplanted to spawn in the Little North Santiam River (approximately 268 fish in 2003).

The recent management strategy has been to release only finclipped hatchery chinook above Detroit Dam. All unmarked fish have remained below Big Cliff Dam or have been outplanted in the Little North Santiam River. Survival of juvenile and adult chinook below the dams has been poor. Mortality rates of over-summering adults has been estimated at 50% to 75% from 2001-03. Even though there have been high numbers of hatchery fish available to spawn below the dams, most of these fish do not live to spawn. From 1997 to 2003, the number of redds observed in the North Santiam below the dams has typically been 100 to 200 (King 2004). The exception was in 2003 when over 800 redds were observed.

Based on the above information, it appears habitat conditions and the natural spawning of hatchery and natural fish below the dams over the last 20 years has not produced many natural origin fish in recent years (now that this can be determined since returning hatchery fish are adipose fin-clipped). This is in contrast to the Clackamas and McKenzie Rivers, where in recent years there have been a few thousand natural fish returning.

Figure 20.6. Return of spring chinook to Minto Hatchery collection facility on the North Santiam River.



Productivity - It is not known whether the hatchery program is increasing or decreasing the productivity rate (the number of recruits produced per spawning fish) of the naturally spawning population. If hatchery fish were just as successful as natural fish, then the productivity rate of hatchery fish would be the same as natural fish. If hatchery fish spawning naturally resulted in fewer recruits the next generation compared to having no hatchery fish spawning naturally (all else being the same), then productivity of the natural population would be reduced by the hatchery program. It is difficult, if not impossible, to quantify what the effects of naturally spawning hatchery fish may be on the natural population when many other environmental and habitat factors also contribute to the productivity of any brood year.

Since some hatchery fish are spawning naturally, there are likely some benefits of the program by providing additional carcass nutrients to the ecosystem after the fish spawn and die. This could help increase overall fish productivity.

Spatial Structure - The North Santiam spring chinook hatchery program may benefit population spatial structure through the outplanting of adult hatchery into historic habitat above the impassable dams. Hatchery fish have been used because of the abundant returns. These fish were locally-derived from wild stock, and can be used to study juvenile survival downstream through

Detroit and Big Cliff dams. Outplanting of hatchery fish above the dams also provides benefits to the spatial distribution of the population. If a catastrophe occurs or natural production fails below the dam, having spawners in historic habitat above the dam would provide some buffer against losses downstream.

It is feasible to outplant only unmarked, natural fish that are collected at Minto Dam to the areas above Detroit Dam and not allow any hatchery fish to interbreed with the wild fish (i.e. create a wild fish sanctuary area above the dam). However, the numbers of natural fish are so low that it was deemed genetic and demographic risks would be of concern. In addition, the relatively high mortality rates of downstream smolts emigrating by Detroit and Big Cliff dams would also be of concern for the few numbers of wild fish present.

<u>Diversity</u> - The life history characteristics of hatchery spring chinook currently in the Willamette Basin differ from those of the historic run. The hatchery fish life history is simplified compared to natural fish (Willis *et al.* 1995). Most of the hatchery fish are released as age-1 smolts in the spring. Whereas in the historic populations, a more continuous run of smolts was observed through the fall and spring periods. Hatchery chinook return at an earlier age than the historic populations. Most of the returns now are age-4 fish instead of age-5 (Willis *et al.* 1995). Given these differences, there are potential risks from having hatchery fish interbreeding with the naturally spawning population. Over the last 20 years hatchery fish have undoubtedly interacted with the natural population on the spawning grounds. Reestablishment of some natural life history diversity in the wild without the continual input of hatchery spawners should help long term viability of this population. Controlling the number of hatchery fish spawning in the wild will also allow the sustainability of the wild run to be evaluated over time without the masking effects of hatchery fish.

20.2.4 South Santiam

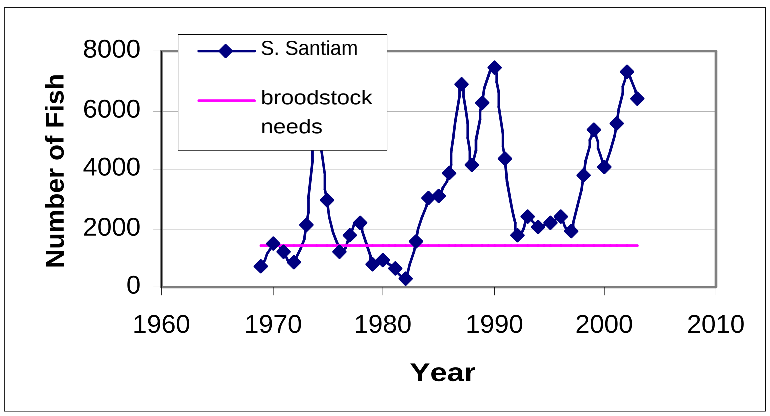
20.2.4.1 Broodstock History. The current hatchery program in the South Santiam was initiated to mitigate for federal dams in the basin. Broodstock was collected from returns to the base of Foster Dam, an impassable dam that blocked access to nearly all of the historical spawning habitat in the basin. Prior to the existing program, broodstock had been taken from local returns since the early 1920's (Myers *et al.* 2002). The existing broodstock is integrated into the local population and has not imported fish from out of basin sources.

20.2.4.2 Similarity between hatchery origin and natural origin fish. There are no genetic analyses available from the South Santiam River. However, due to the large numbers of hatchery fish spawning in the wild below Foster Dam for at least the last two decades, it is expected hatchery fish have introgressed into the natural population. Since hatchery fish make up most of the natural spawners, it is likely these fish are contributing to the overall production in the basin (Schroeder *et al.* 2004).

20.2.4.3 Program Design. The program is designed to mitigate fishery losses from federal dams in the basin and provide fish for commercial and recreational harvest. Fish from the hatchery program are likely integrated with the natural population because broodstock is collected from returns to the base of Foster Dam. Since the program was initiated it has likely incorporated natural-origin fish into the broodstock, although the exact levels are unknown because hatchery and natural fish could not be differentiated until recently. High numbers of program fish have been spawning below Foster Dam naturally for at least the last two decades and comprise the majority of spawners. Broodstock are collected throughout the entire run. All hatchery releases are 100% externally marked. It is likely hatchery and natural fish have a close resemblance due to past management practices and because the extent of hatchery fish spawners could not be controlled below Foster Dam. Current management is focused on developing a locally-adapted broodstock that incorporates some natural fish on an annual basis (NMFS 2000).

20.2.4.4 Program Performance. The *smolt-to-adult* survival rate of the South Santiam Hatchery stock has averaged 0.49% for brood years 1987-1996 (Figure 20.5; ODFW South Santiam HGMP 2004). The broodstock goal for the current production level is approximately 1,400 fish. Total returns of hatchery fish from this program has exceeded the broodstock goal every year for the last 20 years (Figure 20.7). Only fish from local returns are used for broodstock (NMFS 2000). Funding for this program comes from Corps of Engineers and ODFW. The long-term funding outlook for this program is very certain.

Figure 20.7. Return of spring chinook to South Santiam Hatchery collection facilities.



20.2.4.5 VSP Effects

Abundance - The South Santiam historically supported a large population of spring chinook that numbered in the thousands of fish annually (NMFS 2000). All of the historic spawning area was lost after the construction of federal dams in the basin with no upstream passage facilities. In the last two years (the first years when hatchery and natural fish could be differentiated), an estimated 829 and 546 natural-origin fish returned in 2002 and 2003 (Firman *et al.* 2003, 2004). These fish would have been produced from fish that spawned naturally in the area below Foster Dam, which were most likely predominately hatchery fish. In 2002, 86% of the carcasses recovered in this area were fish of hatchery origin (Schroeder *et al.* 2004). The program is increasing the number of spawners below Foster Dam.

Natural and hatchery fish have been outplanted above Foster Dam in recent years in an effort to re-establish natural spawning in historic habitat. Of the fish released above Foster Dam in 2002 and 2003, hatchery fish represented 9% and 27% of the fish released, respectively (Firman *et al.* 2003, 2004). Spawning surveys were not conducted above the dam, so it is unknown how many of these fish actually survived until spawning.

The South Santiam Hatchery has averaged 3,025 fish at the collection facilities at the base of Foster Dam from 1969 to 2003. Returns have consistently exceeded broodstock goals since the early 1980s (Figure 20.7). Based on existing production goals, it appears the program is at little risk of not returning sufficient numbers of fish to meet broodstock goals.

<u>Productivity</u> - It is not known whether the hatchery program is increasing or decreasing the productivity rate (the number of recruits produced per spawning fish) of the naturally spawning population. If hatchery fish were just as successful as natural fish, then the productivity rate of hatchery fish would be the same as natural fish. If hatchery fish spawning naturally resulted in fewer recruits the next generation compared to having no hatchery fish spawning naturally (all else being the same), then productivity of the natural population would be reduced by the hatchery program. It is difficult, if not impossible, to quantify what the effects of naturally spawning hatchery fish may be on the natural population when many other environmental and habitat factors also contribute to the productivity of any brood year.

Since some hatchery fish are spawning naturally, there are likely some benefits of the program by providing additional carcass nutrients to the ecosystem after the fish spawn and die. This could help increase overall fish productivity.

<u>Spatial Structure</u> - The hatchery program is being used to reintroduce fish above Foster Dam (an impassable dam). In 2002 and 2003, approximately 70 and 151 finclipped hatchery fish were outplanted, respectively (Firman *et al.* 2003, 2004). An additional 695 and 401 unmarked adults were also outplanted. Additional supplementation in the areas above Foster Dam with hatchery fish may decrease some of the demographic risks associated with too few natural fish being outplanted.

<u>Diversity</u> - The life history characteristics of hatchery spring chinook currently in the Willamette Basin differ from those of the historic run. The hatchery fish life history is simplified compared to natural fish (Willis *et al.* 1995). Most of the hatchery fish are released as age-1 smolts in the spring. Whereas in the historic populations, a more continuous run of smolts was observed through the fall and spring periods. Hatchery chinook return at an earlier age than the historic populations. Most of the returns now are age-4 fish instead of age-5 (Willis *et al.* 1995). Given these differences, there are potential risks from having hatchery fish interbreeding with the naturally spawning population. Over the last 20 years, hatchery fish have undoubtedly interacted with the natural population on the spawning grounds. Reestablishment of some natural life history diversity in the wild without the continual input of hatchery spawners should help long term viability of this population. Controlling the number of hatchery fish spawning in the wild will also allow the sustainability of the wild run to be evaluated over time without the masking effects of hatchery fish.

20.2.5 Calapooia

The Calapooia River historically supported a demographically independent population of spring chinook that is now extirpated, or nearly so (Myers *et al.* 2002). In recent years, nearly all of the natural spawners observed in the Calapooia have been of hatchery-origin (Schroeder *et al.* 2004). Live adults from South Santiam Hatchery stock have been outplanted into the Calapooia. However, their survival is poor and few survive to spawn. In 2003, a year of large returns of chinook throughout the Willamette Basin, Schroeder *et al.* (2004) observed two redds in nearly eight miles of surveyed stream.

It is clear the Calapooia River does not support a viable population. The natural population is likely extinct and the outlook for recolonization of the Calapooia by natural-origin fish from other nearby areas is unlikely. The most promising hope for rebuilding a small natural run of spring chinook is by using hatchery fish. The current stock of fish outplanted to the Calapooia is from the South Santiam hatchery. This stock of fish is not the ideal stock of fish to use for reintroduction efforts, but a local stock does not exist. It is unclear at this time whether the South Santiam stock would be the best hatchery stock. It seems a hatchery program could benefit the reestablishment of a natural population in the Calapooia River once the most appropriate stock of fish and type of release (adult, fry, smolt) is determined. The Calapooia will never likely support a large run of fish because of the small size of the subbasin.

20.2.6 McKenzie

20.2.6.1 Broodstock History. Broodstock for hatcheries have been collected from the McKenzie River since 1902 (Myers *et al.* 2002). For the existing program, broodstock have been collected solely from local returns. It is unknown the extent to which natural fish have been incorporated into the broodstock in the past because hatchery fish could not be differentiated from natural fish. In recent years, information has shown approximately 10% of the broodstock have been natural-origin fish (Firman *et al.* 2004). NMFS (2000) imposed limits on the number of natural fish that could be used for broodstock because of concerns about mining the natural run since its status was unclear at that time due to unmarked hatchery fish. Future management will likely incorporate more than 10% natural fish into the broodstock.

20.2.6.2 Similarity between hatchery origin and natural origin fish. The genetic analyses included in Myers *et al.* (2002) showed both hatchery and natural fish in the Willamette River Basin are very distinct from other chinook stocks in the Columbia River Basin. Within the Willamette River, the analyses showed significant differences between hatchery and natural fish, but there was no geographical pattern to the diversity (i.e. hatchery fish in the McKenzie were not most closely related to the natural fish in the McKenzie). Myers *et al.* (2002) stated the relatively low sample size of the natural fish from one juvenile age class may have produced misleading results for natural fish throughout the ESU.

Given the current hatchery program was founded from natural fish in the McKenzie River and the program has likely incorporated at least some natural fish into the broodstock over the years, and the high levels of hatchery fish spawning naturally, hatchery and natural fish probably show some genetic similarity.

20.2.6.3 Program Design. The hatchery program in the McKenzie is not intended to supplement natural spawning in the basin. However, the numbers of hatchery fish spawning in the wild cannot be adequately controlled. In recent years, the percentage of the total run passing Leaburg Dam that were hatchery fish has ranged from 33% to 43% from 2001 to 2003 (Firman *et al.* 2004).

Broodstock is collected throughout the entire run of spring chinook. All the juvenile smolts released from the program are adipose fin-clipped.

20.2.6.4 Program Performance. The *smolt-to-adult* survival rate of the McKenzie Hatchery stock has averaged 0.43% for brood years 1987-1996 (Figure 20.5; ODFW McKenzie HGMP 2004). The broodstock goal for the current production level is approximately 800 fish. Total returns of hatchery fish from this program has exceeded the broodstock goal nearly every year since 1969 (Figure 20.9). Funding for this program comes from Corps of Engineers and ODFW. The long-term funding outlook for this program is very certain.

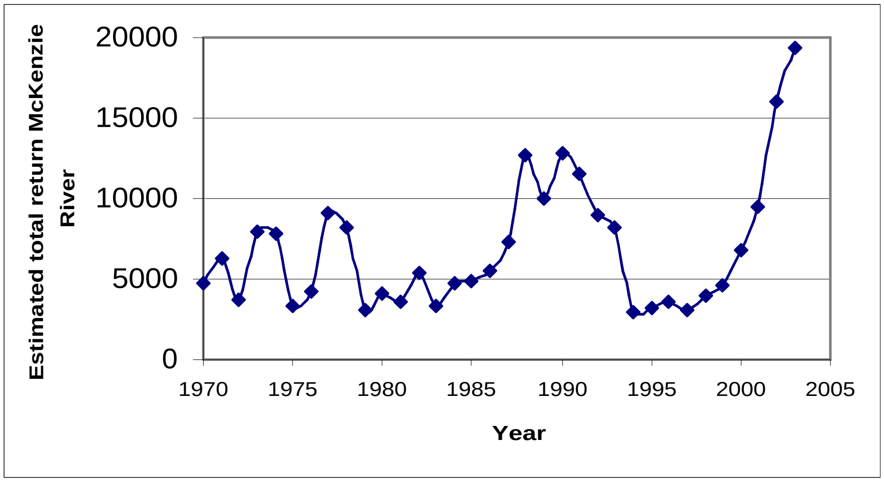
20.2.6.5 VSP Effects

Abundance - The McKenzie River still supports a run of natural-origin fish that numbers in the thousands annually (King 2004). The number of natural fish passing Leaburg Dam in 2003 was more than 5,700 adults (the highest count since wild fish counting began in 1994). The average number of natural fish at Leaburg Dam from 1994 to 2003 is 2,100 adults. Most of the historic habitat is still naturally accessible to spring chinook in the McKenzie River. The downstream effects from the operation of Blue River and Cougar dams are not as problematic for spring chinook as have been observed below other federal dams in the Middle Fork, South Santiam, and North Santiam rivers. Prespawning mortality rates of adult spring chinook in the McKenzie are the lowest (7% to 21% for 2001-03) observed for any Willamette tributary (Schroeder *et al.* 2004).

The hatchery program has been increasing the number of natural spawners below and above Leaburg Dam (Firman *et al.* 2003, 2004; Schroeder *et al.* 2003, 2004). In recent years, hatchery fish have comprised 33% to 43% of the natural spawners above Leaburg Dam (Schroeder *et al.* 2004). Below Leaburg Dam, hatchery fish have comprised more than 70% of the natural spawners in 2003 (Firman *et al.* 2004). It is unknown if the high level of hatchery fish on the spawning grounds in recent years is representative of what occurred over the last few decades. It is possible hatchery fish spawning has been elevated in recent years because of the very high returns of both hatchery and natural fish since 2000 (Figure 20.8). The estimated total return of spring chinook to the McKenzie River has been more than 16,000 fish in 2002 and 2003- more than any year since 1970.

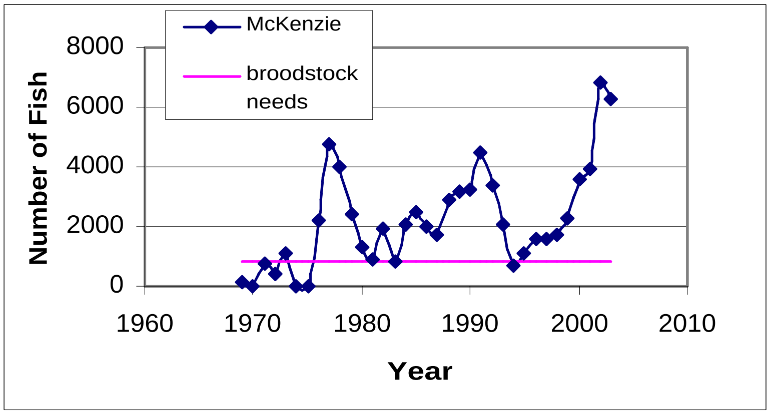
The hatchery program also outplants live adults above Cougar and Blue River dams (impassable dams in the headwaters of the McKenzie basin). In 2002 and 2003, more than three thousand hatchery fish have been outplanted above Cougar Dam into historic habitat in the South Fork McKenzie River (Firman *et al.* 2003, 2004). These adult outplants have produced smolts that have been observed downstream at Cougar Dam (M. Wade, ODFW, personal communication).

Figure 20.8. Estimated total return of natural and hatchery spring chinook to the McKenzie River (King 2004).



Returns of hatchery fish back to McKenzie Hatchery has been consistently above broodstock needs (Figure 20.9). Hatchery fish are also collected from Leaburg Dam when possible to help manage the percentage of hatchery fish spawning in the wild. In years when returns to the hatchery may be insufficient to meet broodstock needs, the trap at Leaburg Dam could be used to supplement hatchery needs. Since returns of hatchery fish have been high and two collection facilities are available, there appears to be little risk of not meeting broodstock needs, assuming current production levels.

Figure 20. 9. Estimated total return of hatchery and natural spring chinook to the McKenzie River (King 2004).



Productivity - It is not known whether the hatchery program is increasing or decreasing the productivity rate (the number of recruits produced per spawning fish) of the naturally spawning population. If hatchery fish were just as successful as natural fish, then the productivity rate of hatchery fish would be the same as natural fish. If hatchery fish spawning naturally resulted in fewer recruits the next generation compared to having no hatchery fish spawning naturally (all else being the same), then productivity of the natural population would be reduced by the hatchery program. It is difficult, if not impossible, to quantify what the effects of naturally spawning hatchery fish may be on the natural population when many other environmental and habitat factors also contribute to the productivity of any brood year.

Since some hatchery fish are spawning naturally, there are likely some benefits of the program by providing additional carcass nutrients to the ecosystem after the fish spawn and die. This could help increase overall fish productivity.

Spatial Structure - The McKenzie Hatchery program is being used to reintroduce hatchery fish back into historic habitat that is blocked by Cougar and Blue River dams (Firman *et al.* 2004). In 2003 more than 3,800 hatchery fish were outplanted above Cougar Dam (Firman *et al.* 2004). The program is providing benefits to the overall spatial distribution of this population. However, there are concerns regarding the potential effects of having progeny from these hatchery fish outplants being indistinguishable from progeny produced by natural-origin spawners in the area above Leaburg Dam (the stronghold natural production area for the ESU). Given the potential risks of having large numbers of hatchery fish intermixing with the natural population, outplanting of hatchery fish above the impassable dams in the McKenzie is of concern.

No hatchery facilities or weirs are known to impede migration or the spawning distribution of this population. Leaburg Dam (owned and operated by Eugene Water and Electric Board) likely has affected the migration and spawning distribution of natural and hatchery fish.

Diversity - The life history characteristics of hatchery spring chinook currently in the Willamette Basin differ from those of the historic run. The hatchery fish life history is simplified compared to natural fish (Willis *et al.* 1995). Most of the hatchery fish are released as age-1 smolts in the spring. In the historic populations, a more continuous emigration of smolts was observed through the fall and spring periods. Hatchery chinook return at an earlier age than the historic populations. Most of the returns now are age-4 fish instead of age-5 (Willis *et al.* 1995). Given these differences, there are potential genetic introgression risks from having hatchery fish interbreeding with the naturally spawning population. Over the last 20 years hatchery fish have undoubtedly interacted with the natural population on the spawning grounds. Reestablishment of some natural life history diversity in the wild without the continual input of hatchery spawners should help long term viability of this population. Controlling the number of hatchery fish spawning in the wild will also allow the sustainability of the wild run to be evaluated over time without the masking effects of hatchery fish.

The McKenzie spring chinook hatchery program is of concern. Since the McKenzie supports the stronghold population of spring chinook for the ESU, it is important to closely manage potential risks from hatchery program on the natural population. In recent years, large numbers of hatchery fish have crossed Leaburg Dam even though NMFS (2000) directs the comanagers to minimize the number of hatchery fish spawning upstream of Leaburg Dam to the maximum extent possible. In 2003, approximately 40% of the spring chinook above Leaburg Dam were hatchery fish. The ladder and trap at Leaburg Dam do not allow large numbers of fish to be sorted efficiently while having minimal handling impacts to natural fish. Only a limited number of hatchery fish can be removed from the dam in years when large numbers of fish are present.

Hatchery fish straying into the only remaining significant wild fish production area in the ESU cannot be controlled adequately. This hatchery program, therefore, represents a risk to the natural population. This natural population would be a strong candidate for designation as a wild fish sanctuary area where hatchery effects would be minimal. However, this is not possible under the current hatchery program.

20.2.7 Middle Fork Willamette

20.2.7.1 Broodstock History. The existing hatchery program was initiated in 1957 to mitigate for fishery losses associated with federal dams in Middle Fork basin. Dexter Dam, the lowermost dam, is impassable to fish. Broodstock for the hatchery was collected from returns to the Dexter trap. Since hatchery fish could not be differentiated from natural fish until 2002, it is unknown how many natural fish have been incorporated into the broodstock over the years. In the early years of the hatchery program, it is likely a significant number of natural fish were incorporated since natural fish were still abundant. In 2002 and 2003, less than 5% of the broodstock has been from natural fish (Firman *et al.* 2003, 2004). The long term intent of the program is to develop a broodstock that incorporates natural fish on a regular basis.

20.2.7.2 Similarity between hatchery origin and natural origin fish. The genetic analyses included in Myers *et al.* (2002) showed both hatchery and natural fish in the Willamette River Basin are very distinct from other chinook stocks in the Columbia River Basin. In the Middle Fork basin, Myers *et al.* (2002) stated juvenile natural fish collected at Dexter Ponds were similar to other natural and hatchery stocks in the ESU. Only a limited amount of data are currently available. It is likely the hatchery stock is most closely related to natural fish more than any other run in the ESU since the broodstock was founded from local returns and hatchery fish have dominated the natural spawning in recent years (Schroeder *et al.* 2004).

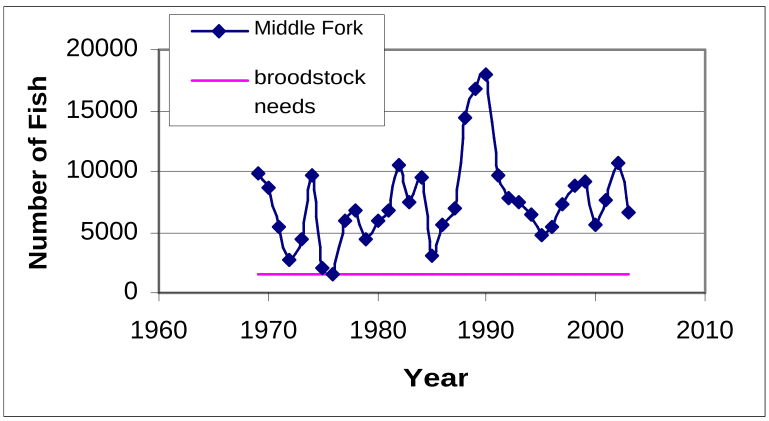
20.2.7.3 Program Design. The program is designed to mitigate fishery losses from federal dams in the basin and provide fish for commercial and recreational harvest. High numbers of program fish have been outplanted above Dexter Dam in recent years and comprise the majority of spawners. However, the exact numbers of spawners is largely unknown because no spawning surveys are conducted. Broodstock are collected throughout the entire run. All hatchery releases are 100% externally marked. It is likely hatchery and natural fish have a close resemblance due to past management practices and because the extent of hatchery fish spawning could not be controlled below Foster Dam. The current management strategy focuses on developing a locally-adapted broodstock that incorporates some natural fish on an annual basis (NMFS 2000).

20.2.7.4 Program Performance. The *smolt-to-adult* survival rate of the Middle Fork hatchery stock has averaged 0.56% for brood years 1987-1996 (Figure 20.5; ODFW Middle Fork HGMP 2004). The broodstock goal for the current production level is approximately 1,600 fish. Total adult returns of hatchery fish from this program has exceeded the broodstock goal every year since 1969 (Figure 20.10). Funding for this program comes from Corps of Engineers and ODFW. The long-term funding outlook for this program is very certain.

20.2.7.5 VSP Effects

Abundance - The Middle Fork Willamette historically supported a large population of spring chinook that numbered in the thousands of fish annually (NMFS 2000). The primary production areas were lost from the construction of federal dams that inhibited upstream passage to over 345 kilometers of habitat (Myers *et al.* 2002). In 2002 and 2003, the only years when adipose fin-clipped hatchery fish could be differentiated from unmarked fish, an estimated 987 and 147 adults returned to Dexter Dam, respectively. However, subsequent analysis has shown that only 10% of the unmarked fish were actually naturally-produced fish, based on otolith readings (Schroeder *et al.* 2004). The unmarked fish were likely hatchery fish released as fry into the reservoirs in the Middle Fork. Therefore, the number of naturally-produced fish returning the last two years has been estimated at less than 100 fish in 2002 and 2003.

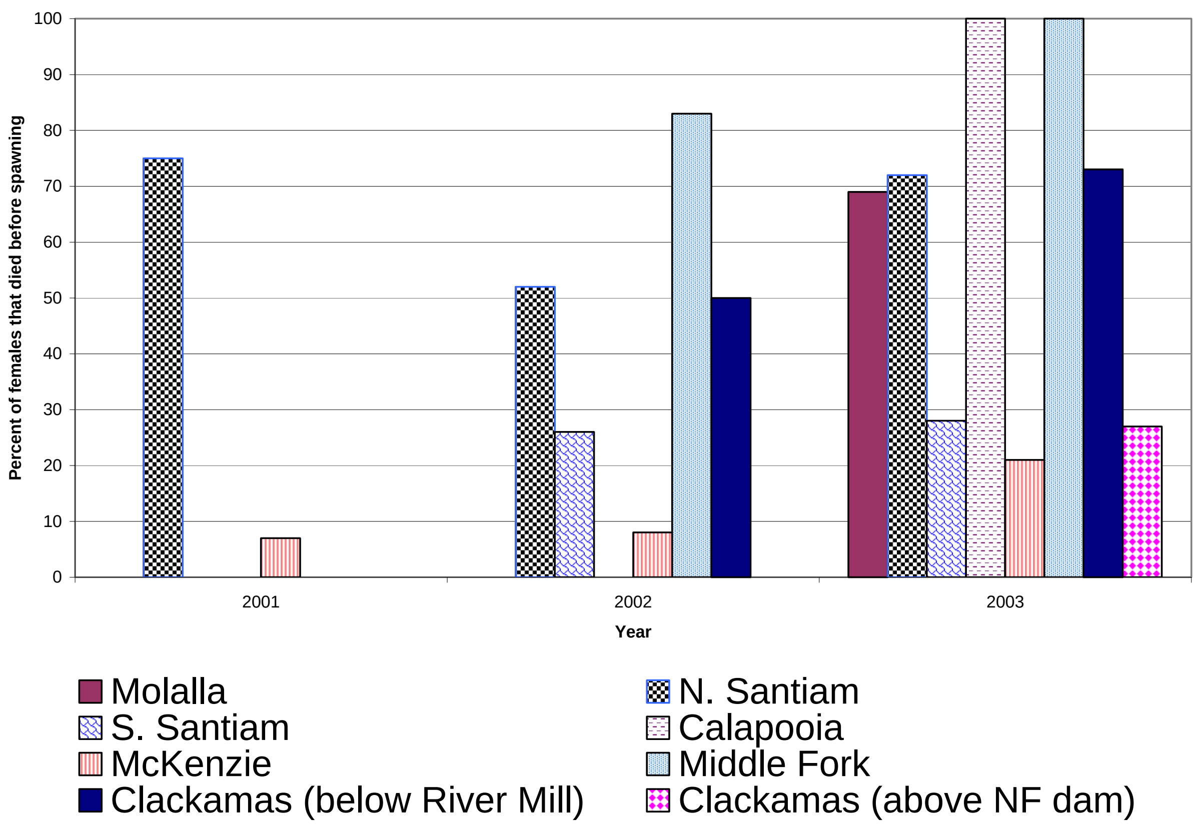
Figure 20.10. Return of spring chinook to Dexter Dam on the Middle Fork Willamette River.



The number of fish (both hatchery- and natural-origin) spawning below Dexter Dam has been low in recent years due to poor over-summer survival (Figure 20.11; Schroeder *et al.* 2004). In 2002 and 2003, prespawning mortality of adults was greater than 80%. In 2003, 14 redds were observed in 17 miles of surveyed area below Dexter Dam (2003 was a very high return year). Preliminary information also indicates spring chinook eggs have a very low survival rate (G. Taylor, USACE, personal communication). The limited number of natural fish observed the last two years were likely produced from juvenile and adult hatchery fish outplanted above Dexter Dam (ODFW Middle Fork HGMP 2004).

Since the number of natural-origin fish returning to the Middle Fork is extremely low, the hatchery program may help reestablish a natural run of fish above the impassable dams. The best stock of fish to use for recovery efforts is probably found in the Middle Fork hatchery stock, which was originally founded from local returns and has likely incorporated some natural fish into the broodstock over the years. The hatchery program is increasing the number of spawners below and above Dexter Dam and in Fall Creek, a tributary to the Middle Fork (Firman *et al.* 2004). In 2003 more than 3,800 spring chinook were outplanted above Dexter/Lookout Point dams.

Figure 20.11. Estimated prespawning mortality rates in each population area. Estimated by the percentage of females carcasses that had not spawned (Schroeder *et al.* 2004).



Returns of hatchery fish to the Dexter Dam trap, where broodstock are collected, are the highest of all the program in the Willamette Basin (Figure 20.10). From 1969 to 2003, an average of 7,500 fish have been collected annually at the trap. Since 1969, the broodstock goal has been attained every year from local returns.

Productivity - It is not known whether the hatchery program is increasing or decreasing the productivity rate (the number of recruits produced per spawning fish) of the naturally spawning population. If hatchery fish were just as successful as natural fish, then the productivity rate of hatchery fish would be the same as natural fish. If hatchery fish spawning naturally resulted in fewer recruits the next generation compared to having no hatchery fish spawning naturally (all else being the same), then productivity of the natural population would be reduced by the hatchery program. It is difficult, if not impossible, to quantify what the effects of naturally spawning hatchery fish may be on the natural population when many other environmental and habitat factors also contribute to the productivity of any brood year.

Since some hatchery fish are spawning naturally, there are likely some benefits of the program by providing additional carcass nutrients to the ecosystem after the fish spawn and die. This could help increase overall fish productivity.

Spatial Structure - The hatchery program is benefitting the spatial distribution of the Middle Fork population because hatchery fish are being outplanted above the impassable dams into historic habitat. Since egg and adult survival is poor below Dexter Dam, outplanting fish back into the headwaters will likely result in more fish production, even though downstream survival through the dams is not high.

Diversity - The life history characteristics of hatchery spring chinook currently in the Willamette Basin differ from those of the historic run. The hatchery fish life history is simplified compared to natural fish (Willis *et al.* 1995). Most of the hatchery fish are released as age-1 smolts in the spring. In the historic populations, a more continuous emigration of smolts was observed through the fall and spring periods. Hatchery chinook return at an earlier age than the historic populations. Most of the returns now are age-4 fish instead of age-5 (Willis *et al.* 1995).

20.3 CONCLUSIONS

Existing Status: Threatened
BRT Finding: Threatened
Recommendation: Threatened

20.3.1 ESU Overview

20.3.1.1 History of Populations

The Willamette/Lower Columbia Technical Recovery Team identified seven historic populations of spring chinook within the Upper Willamette ESU (Myers *et al.* 2002). Most of these populations are nearly extirpated, with very low numbers of natural-origin fish returning in recent years. The McKenzie and Clackamas Rivers support the highest numbers of naturally produced spring chinook in the ESU.

20.3.1.2 Association between Natural Populations and Artificial Propagation

Natural populations "with minimal genetic contribution from hatchery fish"

There are no populations within the ESU that likely have minimal genetic contribution from hatchery fish. All of the seven populations have varying degrees of hatchery fish spawning in the wild. In the McKenzie River (the stronghold natural fish production area), hatchery fish have comprised more than 30% of the natural spawners in the basin since 2001 when hatchery fish could be differentiated from natural fish. Most of the other populations have predominately hatchery fish spawners.

Natural[a] populations "that are stable or increasing, are spawning in the wild, and have adequate spawning and rearing habitat" [b]

There are no natural populations within the ESU that do not have an associated hatchery program. The McKenzie and Clackamas Rivers currently support the

[a] See HLP for definition of natural, mixed and hatchery populations

[b] HLP Point 3

most spawning habitat that is still naturally accessible to spring chinook. Natural fish returns to these areas have increased in recent years. However, the long term trends are still negative. Hatchery fish returns exceed natural fish returns in both of these basins.

Mixed (Integrated Programs[c])
All of the populations identified in the ESU have integrated hatchery stocks.

Hatchery (Isolated[d])
None.

20.3.2 Summary of ESU Viability

20.3.2.1 Abundance. The highest risk factors for this ESU are low abundance of natural fish and reduced spatial structure of the populations (BRT 2003). The first year natural fish could be differentiated from hatchery fish based on mass marking for this ESU was in 2002 (through age 5 fish). In the last two years, approximately 10% of the returns to the Willamette River have been unmarked fish (King 2004). Most of the natural fish return to the Clackamas and McKenzie Rivers. All of the other populations have very low numbers of natural fish returning. There is concern about the very high mortality rates (70% to 100%) of adult fish prior to spawning in most rivers. Less than a few hundred natural fish have been estimated returning to the Middle Fork Willamette and North Santiam Rivers in 2002 and 2003. The low returns of natural fish to the rivers and prespawn mortality rates in excess of 50% (Schroeder *et al.* 2004) results in few naturally-produced spawners for these populations. Critically low abundances of natural origin spawners occurs in the Molalla, North Santiam, Calapooia, and Middle Fork populations. See the Results Section for further information on returns to each river.

20.3.1.2 Productivity. Information on the productivity rates (recruits per spawner) of naturally spawning fish in each of the populations within the ESU is sparse. Productivity rates have likely been less than one for most, if not all, of the populations over the last several decades since natural fish abundance has been steadily declining. All of the rivers have a substantial number of naturally spawning hatchery fish. It is unknown whether the hatchery fish spawners are increasing or decreasing the productivity rate of the local population spawning in the wild. In the areas downstream of the impassable dams, habitat conditions and water quality are probably the most limiting factor and not the abundance of hatchery fish spawners.

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[c] Integrated programs follow practices designed to promote and protect genetic diversity and only use fish from the same local population for broodstock (both natural-origin fish, whenever possible, and hatchery-origin fish derived from the same local population and included in the ESU). Programs operated to protect genetic diversity in the absence of natural-origin fish (e.g., captive broodstock programs and the reintroduction of fish into vacant habitat) are considered “integrated”.

[d] Isolated programs do not follow practices designed to promote or protect genetic diversity. Fish that are reproductively isolated are more likely to diverge genetically from natural populations included in the ESU and to be excluded themselves from the ESU.

In the areas upstream of the dams where hatchery fish have been outplanted as adults, monitoring has shown these fish are producing outmigrating smolts (e.g. above Cougar Dam on the McKenzie River). These outplanting efforts are likely resulting in more fish production in the ESU. However, it is unknown if the hatchery programs are resulting in a benefit to the overall productivity rate of the ESU.

20.3.1.3 Spatial Structure . The highest risk factors for this ESU are low abundance of natural fish and reduced spatial structure of the populations (BRT 2003). Most of the historic spawning habitat in the ESU is now blocked by impassable dams. In the North Santiam, South Santiam, and Middle Fork basins, the most productive spring chinook habitat is no longer naturally accessible to fish. Recently, hatchery fish have been outplanted above the dams in an effort to reintroduce fish back into historic habitats. It is unknown how successful these efforts will be in producing fish due to the high mortality rates of smolts emigrating through the reservoirs and dams. However, expanding the distribution of spring chinook back into historic habitats is probably beneficial, especially given the high prespawn mortality rates that have been observed for adult fish residing below the dams (Schroeder *et al.* 2004).

20.3.1.4 Diversity. Hatchery fish have a simplified life history compared to natural fish in the ESU. Most hatchery fish are released as age-1 smolts in the spring and return as adults at a younger age and later in the year than the historic natural run of fish (Willis *et al.* 1995). All of the hatchery stocks in the Willamette Basin are still more closely related to one another than other spring chinook stocks outside the Willamette Basin. The programs are now being managed to develop locally-adapted broodstocks and all interbasin stock transfers have been eliminated, which will likely help reestablish some stock diversity throughout the ESU.

20.3.3 Artificial Propagation Record

20.3.3.1 Experience with Integrated Programs. The Clackamas, North Santiam, South Santiam, McKenzie, and Middle Fork hatchery stocks were derived from spring chinook returning to the Willamette River. These hatchery stocks resemble other Willamette stocks more than chinook stocks from outside the basin (Myers *et al.* 2002). All of these programs have been in operation for at least two decades.

20.3.3.2 Are Integrated Programs Self-Sustaining. All of the current hatchery programs in the Willamette Basin produce adult returns in excess of broodstock goals. Spawner to spawner replacement rates have averaged more than one since the programs have been in operation. See Results Section for further information.

20.3.3.3 Certainty that Integrated Programs will Continue to Operate. Funding for all of the programs is certain since the programs are mitigation for fishery losses associated with dams in the Willamette Basin. In recent years, monitoring and evaluation supporting effective adaptive management are strengths of these propagation programs.

20.3.4 Summary of Overall Extinction Risk Faced by the ESU

There are significant concerns in all risk factors for the Upper Willamette River spring chinook ESU. Recent improvements in the total return of spring chinook to the Willamette River since

1997 has been positive. In 2002 and 2003 (the first years hatchery fish could be distinguished from natural fish), the estimated returns of unmarked fish to the Molalla, North Santiam, Calapooia, and Middle Fork Rivers has been low. These low returns and recent information showing very high mortality rates of adult fish prior to spawning, results in critically low abundances of spawners in these areas. The number of natural spawners in the Clackamas above North Fork Dam and the McKenzie above Leaburg Dam has shown improvements in recent years and these areas represent the stronghold spawning areas for the ESU. However, even in the Clackamas and McKenzie Rivers, a substantial number of the spawners are of hatchery-origin, which confounds the assessment of whether these two populations are in fact self-sustaining. It is unknown if the hatchery programs will be successful at reintroducing spring chinook above the impassable dams back into historic habitat, given the downstream and upstream passage constraints.

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